UTILITIES INTEGRATED MASTER PLAN

Water Resources Chapter

Water History, Demand, Existing Supplies and Future Water Needs and Recommended Options

EXECUTIVE SUMMARY REPORT

April 8, 2011

City of Flagstaff - Utilities Division

REGISTERED GEOLOGIST
CERTIFICATE NO.
25371
BRADLEY M.
HILL
Date Signed.....
ARIZONA, U.S.A.

EXPIRES 03/31/12

Table of Contents
Complete Report

LIST OF FIGURES and TABLES

Executive Summary Report Only

ACKNOWLEDGMENTS

Staff Contributions

Randy Pellatz, P.E.	Utilities Director
Bradley M. Hill, R.G.	Water Resources Manager - Hydrologist
Connor Boyle, P.E.	Stormwater Project Manager
Debra Valencia	Administrative Specialist
Angie Conner	Utilities GIS Analyst
Robin Harrington	Utilities Program Manager

Outside Contributions

Lee A. Storey, Esq. – Attorney, Ballard Spahr Law Offices

Presented to and Reviewed by the following

Flagstaff City Manager's Sustainability Cabinet *(February 9, 2011)*

Water Commission: Citizens Advisory Committee *(February 17, 2011)*

Coconino Plateau Water Advisory Council *(March 25, 2011)*

Sustainability Commission: Citizens Advisory Committee *(proposed – April 13, 2011)*

Friends of Flagstaff's Future (F^3) Board of Directors *(proposed – April 21, 2011)*

Flagstaff City Manager's Planning Cabinet *(no date)*

Selected community stakeholder groups as appropriate *(no date)*

Flagstaff City Council *(no date)*

EXECUTIVE SUMMARY

The purpose of the overall master plan is to provide the City's Utilities Division guidance for long-term planning, quantify the needs of water resources and determine the necessary water, wastewater and reclaimed water infrastructure needed over time. The objective of the master plan is to collect, analyze and provide information in one location in order to provide the most cost effective, reliable service to the City's utility customers. The master plan is broken into five (5) chapters with the first discussing water resources and water production, identification of long-term water needs and providing recommended options and their respective costs for consideration. Chapters Two through Four will describe the existing water, wastewater and reclaimed infrastructure systems, develop performance criteria based upon hydraulic modeling and lastly to project the necessary infrastructure needed over time and at build-out (i.e., pipelines and treatment capacity). Chapter Five will consist of a comprehensive set of formal water policies adopted by the City Council.

The City of Flagstaff has been importing water in order to maintain a viable economy since the late 1880s. In fact, nearly 100% of the City's water supplies have been imported from outside the incorporated limits for the past 120 years via three importation projects (Inner Basin, Lake Mary and Woody Mountain). It was not until the late 1990s that groundwater supplies have been developed locally within the City limits. Additionally, throughout Flagstaff's history, there have been numerous attempts at solving the challenging issues associated with providing a reliable water supply to this mountain town. Many of these water augmentation projects never became a reality but are summarized in this report as a reminder of the creative ideas and substantial work completed by prior water managers and elected officials.

The City provides water and sewer services under a regulatory framework that includes both State and Federal government oversight. Specifically, Flagstaff's Utilities Division is regulated by the Arizona Department's of Water Resources (ADWR) and Environmental Quality (ADEQ) under a variety of state-based programs while the U.S. Environmental Protection Agency oversees the City's compliance with national water quality and wastewater regulations. City ordinance provides for a stringent set of water conservation strategies in the event of a prolonged drought or other water shortage.

The Utilities Division is continually evaluating ways to manage and deliver water services in a more cost effective and sustainable manner. The Total Water Management concept is to balance the management of our region's water supplies in concert with the environment by making decisions that include not only economic considerations but identified environmental and social elements that are important to the community. One method to track and measure the success in accomplishing this goal is through triple bottom line reporting. Specifically, this type of reporting not only considers the traditional metrics of the utilities economics and water rates, but also tracks environmental metrics such as reduced energy usage (carbon footprint) due to

efficiencies gained and renewable energy sources employed (e.g., environmental element) and/or educational outreach to schools about water conservation and how much recreational activities are supported by reclaimed water (e.g., social element).

The City's potable water needs have grown from 1,240 acre-feet per year (AF/year) to 8,400 AF/year over the past 60 years since detailed records were kept. However, due to water conservation efforts and the implementation of a reclaimed water system for irrigation and industrial purposes, potable water use has stabilized for the past two decades even though population has increased 42% during the same time period. Another indicator of this is that water use measured as Total Gallons per Capita per Day (GPCD) has decreased from 166 in 1990 to 113 in 2010 (Figure 1). While the City has a very low Total GPCD, it has one of the lowest Residential GPCD rates in Arizona, 58 GPCD (Table 1).

The City obtains its water supplies from three primary sources; surface water, groundwater and direct delivered reclaimed water. Surface waters from the Inner Basin and Upper Lake Mary have provided 49% of the City's potable water supplies over the past 60 years (Figure 2). Groundwater from the Woody Mountain well field has contributed 23% while the Lake Mary well field has contributed 20% over the past 60 years. Groundwater from the Local well field has contributed 3% of the City's total water supply, but only since the last 10 years. Lastly, direct delivered reclaimed water now makes up a significant portion of the City's total water deliveries. In fact, in 2010 reclaimed water made up 18% of the City's total water deliveries (Table 2).

Existing potable water supplies have been estimated to have a sustainable yield of approximately 11,000 AF/year. To better define this volume, the City is undertaking a computerized groundwater modeling study based upon the information contained within the U.S. Geological Survey's regional northern Arizona model. When completed, this study should provide the first scientific estimate that is based upon the Arizona Department of Water Resources (ADWR) Hydrologic Guidelines for evaluating the physical availability of Flagstaff's water supplies. This effort will help the City comply with and maintain its existing Designation of Adequate Water Supply from ADWR.

Flagstaff's legal rights to its water supplies is generally defined within the western United States legal doctrine of prior appropriation otherwise known as "first in time, first in right". The City began to first use water from the Inner Basin in 1895 or prior by the Santa Fe railroad for municipal and industrial purposes. Water from the Lake Mary - Walnut Creek watershed was first used in 1903. The City's rights to reclaimed water are primarily within the Arizona Supreme Court case APS v. Long which essentially stated that the ownership of the effluent (reclaimed water) is with the entity that produces the effluent and puts it to beneficial use regardless of the original source of the water. The scope, priority and extent of these rights are being confirmed within the on-going Little Colorado River and Gila River Adjudication superior court proceedings.

A sophisticated geographical informational system (GIS) study was undertaken to determine water use for a variety of residential and non-residential categories. Also calculated was the maximum potential number of housing units at build-out. The first part of the study incorporated historical water billing data (2003-2010) with spatial data from the City's GIS regarding land use types, lot sizes and building footprints. An overall summary of the 8-year water use averages were calculated as either Gallons per Household per Day (GPHD) for residential (single & multi-family) or as Gallons per Acre per Day (GPAD) for non-residential (commercial, industrial, etc) and are provided in Table 3. The second part of the study estimated the future maximum build-out based upon land uses contained within the voter approved 2001 Regional Land Use and Transportation Plan. This GIS analysis calculated that there is approximately 7,650 acres of land remaining within City limits that could be developed after removing those lands designated as open space. When using the maximum allowable densities within the voter approved Regional Plan for the undeveloped lands, the GIS analysis estimated that there could be up to approximately 38,000 new residences within the City of Flagstaff (Table 4).

The City conducted a two pronged approach at determining its long-term water needs that included eight separate plausible Scenario's of Flagstaff's future. The Population Projection Method incorporated two different rates of future growth while the Land Use Method used the voter approved 2001 Regional Transportation and Land Use Plan. Additionally, these scenarios included potential reductions to the City's surface water sources due to possible changes in climate in the future and a possible 20% further reduction in water use due to new water conservation efforts. Both of these methodologies yielded a range of potential water needs scenarios over time and at build-out (Table 5). Scenario 1 (i.e., base case) of the Population Projection Method estimated the future additional water needs between 12,100 AF/year to 14,300 AF/year assuming a historical annual growth rate (1.4%) and water use (Total GPCD 114). Build-out was reached within approximately 70 years (Figures 3.1 and 3.2). Scenario 4 of the Population Method estimated the future water needs between 7,700 AF/year to 9,900 AF/year assuming a slow annual growth projection (< 1.0%) and an additional 20% reduction in water conservation (Total GPCD 91). Build-out was reached in 145 years (Figures 3.3 and 3.4). Both of these Scenarios assumed that surface water supplies could be reduced to zero in any given year due to prolonged drought. Scenario 1 (i.e., base case) of the Land Use Method estimated future water needs at 16,500 AF/year with no time frame for when build-out is reached. Scenario 2 ("modified Industrial") of the Land Use Method estimated future water needs at 9,500 AF/year assuming low water use commercial and industrial businesses were to locate in Flagstaff. A "conservative" target of 12,000 AF/year of additional new water supplies was recommended which equates to the mid-point between all of the varying Scenarios (Table 5). However, this assumes that additional water conservation measures will be implemented on a mandatory basis.

Future water supply options were identified in order to make up for the additional long-term water needs of 12,000 AF/year. These alternatives include both locally derived

and new imported supplies. The options considered were additional water conservation measures (e.g., active rainwater harvesting, high-efficiency and composting toilets, etc), new groundwater wells, increased treatment of reclaimed water, imported groundwater from Red Gap Ranch and imported surface water from the Colorado River. A 10-year economic analysis was undertaken for each of the options. Additionally, the maximum potential volume of water saved for each option was also estimated. The purpose of this analysis was to compare each option objectively from both an economic and water savings perspective (Table 6).

The highest cost per unit option (~$5,000/AF) with a low volume of water saved (20 AF/year to 232 AF/year) was mandatory active rainwater harvesting for all new buildings. This estimate of low volume – high unit cost for employing rainwater harvesting on an individual, City-wide basis is supported by other economic and water supply analyses that have been conducted around the State. However, other water conservation measures evaluated (e.g., high efficiency toilets, washing machines and turf rebates) have a relatively low cost per unit of water saved and potentially saving a significant volume of water collectively. The least cost alternative ($25/AF) with a relatively low maximum potential volume of water saved (311 AF/year) was the retrofitting of toilets that were installed in homes between 1980 and 1994 with high-efficiency (HET) toilets. The highest volume of water potentially saved was the removal of turf (1,499 AF/year). This option has a low per unit cost ($297/AF) but could be expensive to the customer. The next most expensive option was estimated to be imported Colorado River water (~$3,000/AF) or groundwater from Red Gap Ranch (~$3,900/AF), however both options could provide the 12,000 AF/year needed for the City to reach build-out.

In conclusion, there are numerous criteria that a municipality like Flagstaff should consider when identifying and developing a strategy for solving future water supply needs. At a minimum these criteria should include the volume of water each alternative option can provide, the cost per acre-foot of each option, known water rights issues, environmental permitting, and feasibility of implementation and political considerations. After a thorough evaluation of these criteria, it is not uncommon for a city to adopt several options as part of their overall strategy, choosing some to implement in the short-term and others in the long-term.

TABLE 1
Comparison of Gallons per Capita per Day (GPCD) Water Use for Select Municipalities in Arizona
(Water Resource Advocates, 2010)
2008 Data

	Residential	**Total**
Flagstaff	*61* [1]	***108***
Buckeye	61	**136**
Chandler	142	**201**
Clarkdale	73	**86**
Lake Havasu City	124	**222**
Mesa	130	**167**
Payson	66	**83**
Phoenix	123	**173**
Prescott	98	**126**
Safford	175	**175**
Scottsdale	249	**302**
Tucson	102	**127**

Note 1 – Flagstaff Residential GPCD includes both single-family and multi-family water use and does not include Lost & Unaccounted for water (2009 Report to the Water Commission). Note that in 2010, Residential = 58 GPCD and Total = 100 GPCD (2011 Report to the Water Commission)

TABLE 2
Historical Population and Water Deliveries
1890 - 2010
City of Flagstaff, Arizona

Date	Population [1]	Water Production [2] (acre-feet)	Total GPCD [3]	Reclaimed Water [4] (acre-feet)	Total Deliveries (acre-feet)
1890	963				
1910	1633				
1920	3186				
1930	3891				
1940	5080				
1950	7,663	1,263.8	147		1264
1960	18,214	2,568.8	126		2569
1970	26,117	4,719.8	161		4720
1980	35,310	6,212.7	157		6213
1985	38,600	7,259.2	168		7,259
1990	45,990	8,541.0	166	1,205	9,746
1995	52,745	7,819.5	132	1,378	9,198
2000	62,710	8,912.5	127	1,574	9,066
2001	57,700	8,804.1	136	1,363	10,167
2002	59,160	8,767.9	132	1,750	10,518
2003	60,750	8,614.3	127	1,612	10,226
2004	61,505	8,249.3	120	2,309	10,558
2005	61,185	8,127.5	119	2,216	10,344
2006	62,030	8,589.3	124	2,231	10,820
2007	64,200	8,884.9	124	2,379	11,264
2008	64,908	8,484.7	117	2,130	10,615
2009	65,522	8,399.9	114	2,141	10,541
2010	65,870	8,353.1	113	1,887	10,240

Note 1: population data from U.S. Census statistics or Arizona Department of Commerce
Note 2: potable water production from Utilities Division - Report to Water Commission, 2010
Note 3: Total GPCD: gallons per capital per day including residential & non-residential (includes Lost & Unnaccounted For water)
Note 4: Direct delivery of reclaimed water from Rio de Flag WRF and Wildcat Hill WWTP. Reclaimed deliveries actually began in 1975, however the early data is unreliable

TABLE 3
Historical Average Water Consumption
2003 - 2010
City of Flagstaff, Arizona
(City of Flagstaff, 2009 and Appendix 4)

Summary Eight Year Water Consumption Averages [1]	
Single Family Housing Units	212 GPHD
Multi Family Attached Housing Units	173 GPHD
Apartment Complexes [2]	160 GPHD
Industrial/Institutional Uses	5251 GPAD
Commercial Uses	861 GPAD
Hotel Room Use [3]	106 GPD
Modular Neighborhood	164 GPHD

GPHD - gallons per household per day
GPAD - gallons per acre per day
GPD - gallons per day

*Note 1: Does not include 10% water loss and unaccounted for water.
*Note 2: In apartment calculations, the Timberline units all had clothes washers. The Lake Mary Apartments were built in two separate phases and clothes waters are included in 100 or the 224 units. Otherwise, occupants in units must rely on laundromats, and that water usage was unaccounted for in the residential calulations.
*Note 3: Includes hotel landscaping and on-site laundry services.

Table 4 – Undeveloped Land Acreages & Projected Water Needs

Table 2
Undeveloped Land Acreages & Projected Water Needs
Using 2001 Regional Plan Land Use data
- Base Case Analysis -
Revised with 2010 committed projects and projected population

LANDUSE CATEGORY per Regional Land Use Plan	Acres	Sq Feet	Aggregated Acres	Aggregated Sq Ft	Sample Avg. Lot Sq Ft.	Approx. # of units by acre	Maximum # of Dwelling Units per Land Use Plan	RESIDENTIAL BUILD OUT WATER NEEDS Acre-Feet/Year	COMMERCIAL BUILD OUT WATER NEEDS Acre-Feet/Acre/Year	Water Use Factors Residential GPHD	Comm/Ind GPAD
Note 1	*Note 1*	*Note 1*					*Note 2*	*Note 3*	*Note 4*	*Note 5*	*Note 6*
Commercial: Neighborhood	40.00	1,855,604	890.63	38,909,041.23	1,931,800.00	n/a	n/a		859		861
Commercial: Office/Business Park - Light Industrial	702.88	30,617,448				n/a	n/a				
Commercial: Regional/Community	147.75	6,435,990				n/a	n/a				
Industrial: Heavy	70.29	3,061,732	1,048.82	45,686,502.55	1,528,593.00	n/a	n/a		6,169		5251
Industrial: Light/Medium	34.24	1,491,564				n/a	n/a				
Institutional: Elementary School	7.36	320,465				n/a	n/a				
Institutional: Hospital/Medical Center	0.06	2,552				n/a	n/a				
Institutional: Middle School	8.73	380,272				n/a	n/a				
Institutional	928.14	40,429,917				n/a	n/a				
Land Bank: Public Multiple Use	15,059.00	655,970,040				n/a	n/a				
Open Space: Golf Course	16.23	706,969				n/a	n/a				
Open Space: Parks	207.00	9,016,920				n/a	n/a				
Open Space: Right of Way	253.78	11,054,652				n/a	n/a				
Open Space: Rural Open Space	6.25	272,290				n/a	n/a				
Open Space: Transition Zone	205.19	8,937,954				n/a	n/a				
Open Space: Urban Open Space	2,452.41	106,826,842				n/a	n/a				
ROW: Right of Way	87.50	3,811,500				n/a	n/a				
Residential: High Density (>12 du/ac) 22 max - *Note 9*	58.20	2,535,192	5,526.65	240,740,778.21	n/a	n/a	1,280	229		160	
Residential: Low Density (1-5 du/ac)	740.79	32,268,875			16,850.00	1,915.07	3,704	858		212	
Residential: Medium Density (6-12 du/ac)	396.80	17,284,608			5,766.67	2,997.33	4,762	923		173	
Residential: Medium Land Bank: PRA (7du/ac)	2,039.16	88,825,651					14,274	2,766		173	
Residential: Medium PMU (7 du/ac) - *Note 10*	1,482.20	64,564,632					10,375	2,011		173	
Residential: Mixed Neighborhood (7 du/ac)	151.50	6,599,340			6,222.86	1,060.50	1,061	206		173	
Residential: Very Low Density (<1 du/ac)	658.00	28,662,480					658	156		212	
Traditional Neighborhood Design (1900 total one project -10du/ac)	181.53	7,907,247	181.53	7,907,247.00			1,900	368		173	
Residential	5,708.17	248,648,025					**38,014**	**8,268**	**7,731**		
Commercial & Industrial & Institutional	1,939.45	84,595,544									
Land Bank & Open Space	18,287.35	796,597,167									
Total Acres of Undeveloped Land within City	25,934.98	1,129,840,736									

BUILD OUT	COMMITTED WATER NEEDS:	584	acre-feet/year
BUILD OUT	PROJECTED WATER NEEDS:	15,999	acre-feet/year
BUILD OUT	**TOTAL WATER NEEDS:**	**27,198**	acre-feet/year
			Note 7
BUILD OUT	COMMITTED POPULATION:	7,423	
BUILD OUT	PROJECTED POPULATION:	106,439	
BUILD OUT	**TOTAL POPULATION**	**178,555**	*Note 8*

NOTES:

1: Data from City GIS Land Database in conjunction with Utilities GIS Program - undeveloped land remaining within City of Flagstaff including those that are City Council approved subdivisions updated to 2010.
1a - Base Case Land Use data from 2001 Regional Plan extracting parcels identified as undeveloped within Dept.of Revenue database
2: Used maximum density allowed for each residential category
3: Used GPHUD figures from Utility Billing for each residential category. Total volume includes 10% Lost & Unaccounted for water
4: Used GPAD figures from Utility Billing analysis for each commercial / industrial category. Total volume includes 10% Lost & Unaccounted for water
5: GPHUD = Gallons per Housing Unit per Day, 8 - year unit average using actual Utility Billing for select subdivisions (refer to analysis sheets)
6: GPAD = Gallons per Acre per Day, 8 - year unit average using actual Utility Billing for select commercial complexes (refer to analysis sheets)
7: TOTAL Water Needs = projected (15,999AF) = current (10,615 AF - according to 2009 Annual Report to the Water Commission/2008 data) = committed (584 AF) water deliveries.
For Committed Water Demand, see Figure 8. Total includes 10% Lost & Unaccounted for Water
8: City Planning calculates 2.8 persons per household. This is multiplied by # dwelling units (38014 projected) and (2615 committed - see Table 10) plus 2008 cuurent populations estiamte of 64,693.
8a - City of Flagstaff Engineering Standards specifies different numbers for single-family and multi-family per person per household
9: In the High Density category, 14 du/ac has been the trend, but 22 du/ac was used as a maximum potential

TABLE 5

Scenario Planning
Final Comparison of Future Water Supply Projections

Land Use Methodology	Unmet Water Needs
Scenario 1 "Base Case"	
Residential	8,400 AF/year
Non-Residential	8,100 AF/Year
	16,500 AF/year
Scenario 2 "Modified Industrial" (reduced industrial water user)	
Residential	8,100 AF/year
Non-Residential	1,350 AF/Year
	9,450 AF/year
Scenario 3 "Modified ASLD"	
Residential	5,930 AF/year [1]
Non-Residential	8,100 AF/Year
	14,030 AF/year
Scenario 4 "Modified Industrial & ASLD"	
Residential	5,930 AF/year
Non-Residential	1,350 AF/Year
	7,280 AF/year

Population Projection Methodology

	Unmet Water Needs	
Historical Growth Rate (1.4%)	Normal Climate	Dry Climate
Scenario 1 "Base Case"	12,100 AF/year to	14,300 AF/year
Scenario 2 > 20% conservation [2]	7,700 AF/year to	9,900 AF/year
Slow Growth Rate (< 1.0%)		
Scenario 3 no new conservation [3]	5,600 AF/year to	7,800 AF/year
Scenario 4 > 20% conservation [2,4]	2,400 AF/year to	4,700 AF/year

Range of Potential Water Needs Projected at Build-Out

7,280 AF/year to 16,500 AF/year or a recommended mid-point target of

***** 12,000 AF/year *****

NOTE 1 - assumes ASLD Trust Lands build-out water needs are reduced from 5,370 AF/year to 2,901 AF/year based upon changes in densities contained within the 2001 Regional Plan and discussed in June 2010. However, these discussions are preliminary and conceptual in nature and neither the City nor ASLD has agreed to anything.

NOTE 2 - assumes an additional 20% water conservation mandatory measures are implemented in order to save 4,400 AF/Year at build-out

NOTE 3 - assumes 7,800 AF/year incremental water supply needs by the year 2100 and 14,300 AF/year by 2155 (dry year water supply conditions)

NOTE 4 - assumes 4,700 AF/year incremental water supply needs by the year 2100 and 9,900 AF/year by 2155 (dry year water supply conditions)

TABLE 6

Future Water Supply Options
Preliminary Estimates of the Volume of Water and their Cost
(over a 10-Year Period)

Water Source	Volume of Water (acre-feet/year)	Cost of Water[1] (acre-foot)	Upfront Cost to Customer
Existing Cost of Water			
Groundwater [2]		$978	
Upper Lake Mary surface water [3]		$318	
1. Water Conservation			
RWH Cisterns new Residential [4,5]	232	$5,500	$3,600
RWH Rain Barrels new Residential [6,7]	93	$1,704	$100
RWH Cisterns new Commercial [4,8]	33	$2,650	$4,720
RWH Cisterns new Institutional [4,9]	20	$2,546	$4,939
RWH Cisterns existing buildings [4,10]	610	???	???
Average per acre-foot		$4,963	
Hot Water Recirculators [7]	225	$1,358	$230
High Efficiency Clothes Washer [7]	220	$505	$993
Incinerating Toilets [7]	588	$1,290	$2,110
Turf (grass) removal [11]	1,499	$297	$2,800
Composting Toilets [7]	565	$1,352	$5,885
HET Toilets (1.3 gal) 1980 – 1994 [12]	311	$25	$278
HET Toilets (1.3 gal) post 1994 [13]	32	$1,901	$278
2. Red Gap Ranch [14]	12,000	$3,857	
3. Reclaimed Water Reuse [15]	4,480	$974	
4. Groundwater supply well [16]	716	$830	
5. Western Navajo Pipeline [17]	8,000	???	
5a. Colorado River–JUST Water [18]	8,000	$3,000	

NOTES:

1 - 10-year estimates in 2010 dollars including upfront capital plus on-going operations and maintenance (O & M) that included electrical energy, if applicable

2 – Actual 1st half FY11 costs for all three well fields that includes: electricity for pumping & boosting into distribution system, chemicals (chlorine), salaries, overhead and all well related debt service

3 – Actual 1st half FY11 costs for Lake Mary Water Treatment Plant (WTP) that includes: electricity for raw water pump station, WTP and boosting to distribution system, chemicals (powdered activated carbon, chlorine dioxide & others), salaries, overhead and debt service.

4 – RWH (active rain water harvesting) - volume of water harvested assumes 30-year historical precipitation (22.5”), cisterns sized to capture a 1“ rainfall will fill 5 times each year for each land use category

5 – Residential active rainwater harvesting using a cistern assumes an average roof area of 2,079 ft^2 and a 13 year payback period

6 – Residential active rainwater harvesting using 2-50 gallon rain barrels assumes capturing 781 gallons per year and a 21 year payback period

7 - Assumes that there is a potential for 36,700 future single family residences. This figure is based upon the maximum densities permitted within the 2001 Regional Transportation and Land Use Plan (Appendix 4 – Table 2)

8 – Commercial active rainwater harvesting assumes an average roof area of 6,488 ft^2 and a 19 year payback period

9 – Institutional active rainwater harvesting assumes an average roof area of 6,856 ft^2 and a 18 year payback period

10 - All existing buildings, no costs for retrofitting were estimated given the variability of each home or business

11 – Turf removal assumes the minimum of 1,500 FT^2 converted to Xeriscape at all existing homes (17,100 homes in 2011 Report to the Water Commission)

12 – High Efficiency Toilet (HET) Retrofit – replacing toilets installed between 1980 and 1994. According to building permit data, approx. 9,219 homes were constructed pre-1994

13 – High Efficiency Toilet (HET) Retrofit - replacing toilets installed post 1994. According to building permit data, approx 7,881 homes were constructed after 1994

14 - Cost includes pipeline, booster pumps and well field infrastructure delivery and O & M

15 - Cost for new additional treatment using HiPOx technology, then recharge & recovery

16 – Cost to locate, design & drill a new well assuming pumping rate of 493 gallons per minute

17 - Cost unknown, will be determined as part of USBR's Feasibility Study and part of the Northeastern Arizona Indian Water Rights Settlement; does not include costs for a Colorado River water supply

18– Cost for water right (paper water) only, does not include infrastructure delivery costs

FIGURE 1

Total Gallons per Capita per Day (GPCD)
1980 thru 2010
City of Flagstaff, Arizona

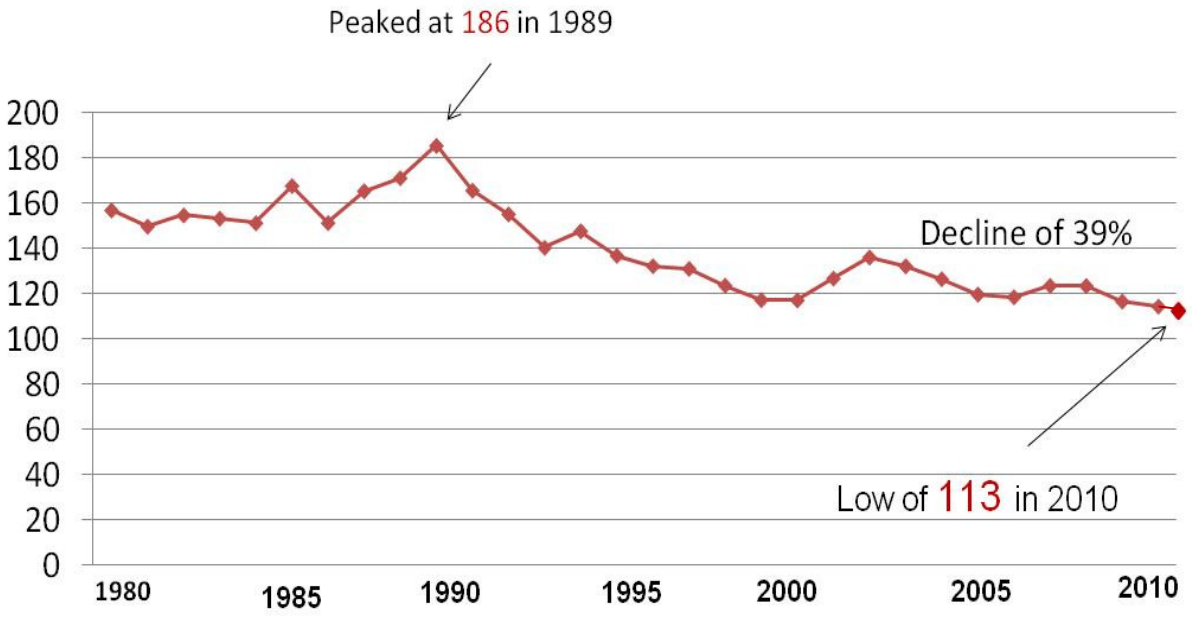

FIGURE 2

Surface Water v. Groundwater Deliveries
1949-2010
City of Flagstaff, Arizona

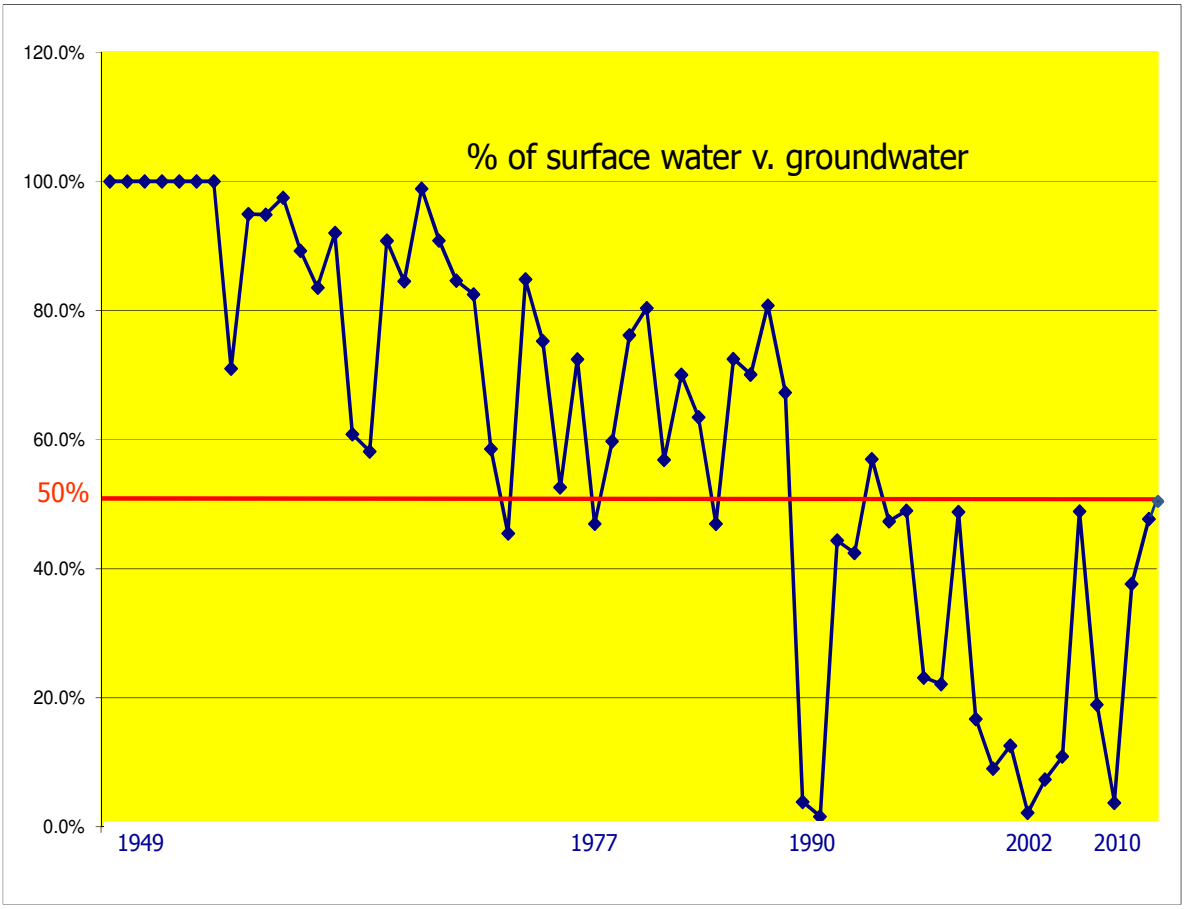

FIGURE 3.1 and 3.2

Scenario 1
Water Resource Need Projections
"Basecase" Historical Rate of Growth
No new Water Conservation

Figure 3.1

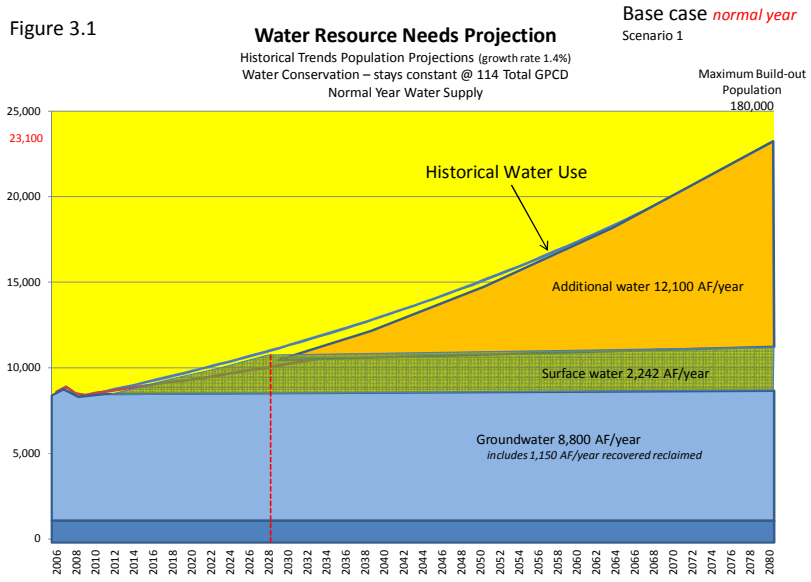

Figure 3.2

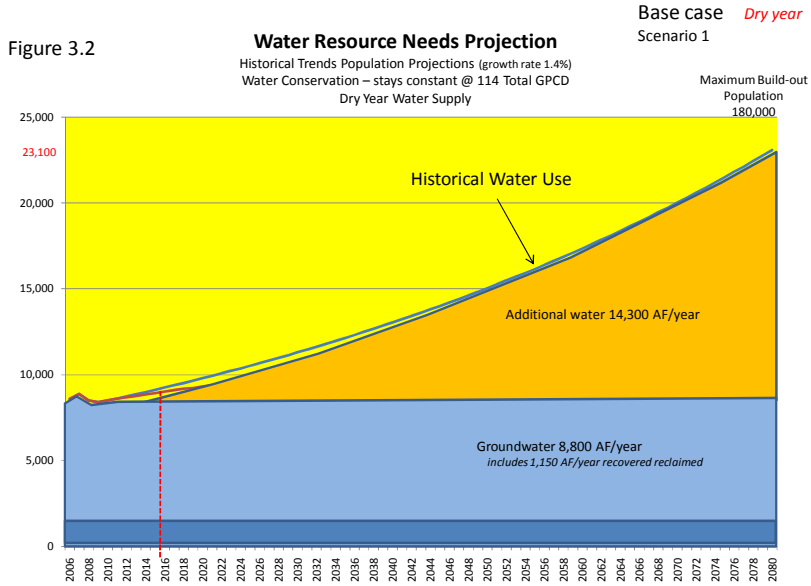

FIGURE 3.3 and 3.4

Scenario 4
Water Resource Need Projections
Slow Rate of Growth
20% Additional Water Conservation

Figure 3.3

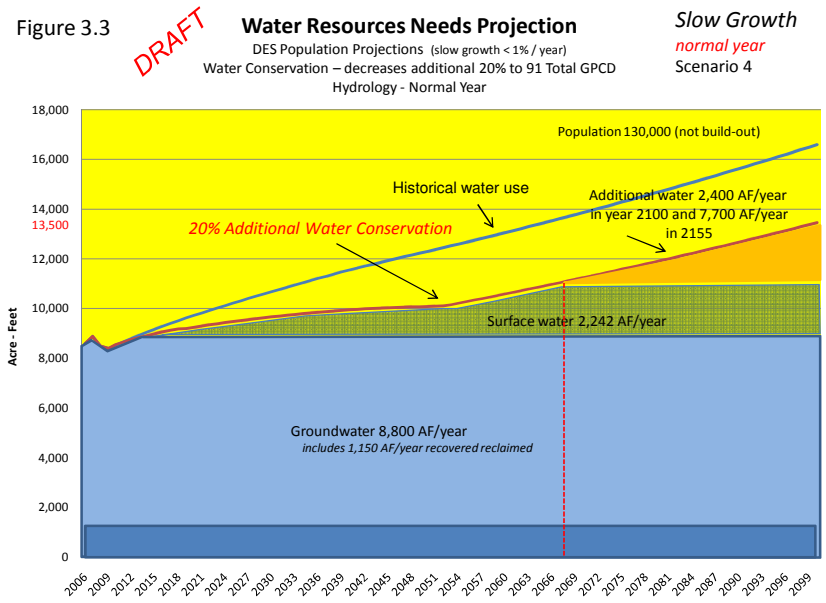

Figure 3.4